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रसायन तथा बहिःस्त्राव के लिए
पॉलीइथार्डलिन पाईप — विशिष्टि
(पहला पुनरीक्षण)

**Polyethylene Pipes for Sewerage
and Industrial Chemicals and
Effluent — Specification**
(*First Revision*)

ICS 23.040.45, 91.140.60, 93.025

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastic Piping System Sectional Committee had been approved by the Civil Engineering Division Council.

This Indian Standard covers requirements and test methods for polyethylene pipes for sewerage and industrial chemicals and effluents.

High density polyethylene (HDPE) pipes for sewerage and industrial effluents were earlier covered along with HDPE pipes for potable water supply in IS 4984 : 1984. The technical committee, in view of the following reasons, felt the need to formulate a separate specification for HDPE pipes for sewerage and industrial effluents:

- a) That pipes meant for sewerage and for industrial effluents are subjected to higher temperature and chemical reactions during its life.
- b) That the maximum specified allowable hydrostatic design stress for water supply pipes at 30 °C for 50 years life used in the calculation of minimum wall thickness needs modifications in view of (a) above.
- c) That pipes meant for water supply and for sewerage/industrial effluents need to be identified separately.

Accordingly, IS 4984 was published in 1995 to cover HDPE pipes for potable water supply only and IS 14333 was first published in 1996 to cover HDPE pipes for sewerage. In view of the reasons stated at (a) and (b) above, the Committee in the absence of any established data for the level of chemical reactions and the rise in temperature above 30 °C, had recommended a derating factor of 0.75 over the maximum allowable hydrostatic design stress of 4.0 MPa used for PE 63 grade material for water supply.

The technical committee had also recommended that the HDPE pipes covered in IS 4984 : 1995 may also be used for industrial effluents provided the user shall establish suitability of the pipes for the intended application based on the chemical resistivity chart given in the standard in consultation with the manufacture of the pipes.

This revision of the standard has been carried out to align the standard with the revised provisions in IS 4984 : 2016. The requirements for raw material, diameter, ovality, wall thicknesses and various tests for the PE resin and pipe have been aligned with IS 4984 : 2016.

Further, all the raw material manufacturers in India are producing PE pipe material in virgin natural form only and presently majority of PE pipes and fittings are being manufactured by compounding natural resin with its master batch. Also, the compounded material and testing facilities for evaluating its minimum required strength (MRS) as per ISO 9080 : 2012 are limited in India. Therefore, the Committee has decided to retain the present practice of manufacturing PE pipes with master batch technology for the black PE pipes, in addition to manufacture using pre-compounded material.

In this revision of the standard, the following major modifications have been made:

- a) The scope has been extended to include polyethylene pipes for industrial chemicals.
- b) As polyethylene pipes are designated by their MRS and PE pipes for industrial chemicals have also been covered, the earlier nomenclature of high density polyethylene pipes for sewerage has been changed to polyethylene pipes for sewerage and industrial chemicals and effluents.
- c) Overall service design coefficient of minimum 1.25 and operating temperature of 30 °C was only covered., which has been revised to cover allowable operating pressure (working pressure) chart for temperature up to 60 °C and overall service design coefficient of 1.25, 1.6 and 2.0.
- d) Tests such as hydrostatic strength for 100 and 1 000 h, slow crack growth rate test, tensile strength for butt fusion, oxidation induction time, and elongation at break have been included for pipes based on IS 4984 : 2016.
- e) The range of nominal diameter has been increased from 1 000 mm to 2 500 mm. Wall thicknesses have been specified based on Standard Dimension Ratio (SDR).

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Indian Standard

POLYETHYLENE PIPES FOR SEWERAGE AND INDUSTRIAL CHEMICALS AND EFFLUENT — SPECIFICATION

(*First Revision*)

1 SCOPE

1.1 This standard specifies the characteristics and requirements for polyethylene pipes intended to be used for following applications above or below ground:

- a) Sewerage (pressure or non-pressure);
- b) Industrial effluent; and
- c) Industrial chemicals.

1.2 This standard covers polyethylene pipes from 63 mm to 2 500 mm nominal diameter of pressure rating from 0.20 MPa (2.0 bar) to 2.0 MPa (20.0 bar).

1.3 The operating temperatures of 10 °C, 20 °C, 27 °C, 40 °C, 50 °C and 60 °C for different service life are covered.

1.4 The reference temperature of 20 °C for 50 years of continuous stress is considered for the minimum required strength (MRS) of polyethylene base resin. The design stress at 20 °C is derived by dividing MRS by the overall service (design) coefficient, *C* which is 1.25 (*Min*) for all polyethylene pipes. This standard specifies overall service design coefficient of 1.25, 1.6 and 2.0 which shall be appropriately selected by the user/design engineer keeping in view the application to which the pipes are subjected to (*see also* Note 1).

NOTES

1 In IS 4984, which covers PE pipes for water supply for human consumption and raw water, the *C* value taken is 1.25. Further, the maximum allowable operating pressure at 27 °C has been obtained by applying a pressure reduction coefficient of 0.85.

2 In this standard, the allowable operating pressure of IS 4984 at 27 °C (for 50 years life) with service design coefficient 1.25 has been taken as reference. The maximum allowable operating pressure for an operating fluid temperature other than 27 °C and service life other than 50 years, can be derived as per **6.1.4**.

1.5 For chemical resistance of polyethylene and its compatibility with various fluids and its performance in different general uses, reference shall be made to IS 16268/ISO TR 10358.

1.6 For pipes for non-pressure applications, PE pipes of stiffness (SN) value of 8 and above shall be used.

Guidance on stiffness class of PE pipes is provided at Annex A.

1.7 This standard does not purport to give guidelines for designing and dimensioning of pipe lines.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated are valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
2530 : 1963	Methods of test for polyethylene molding materials and polyethylene compounds
4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (<i>first revision</i>)
4984 : 2016	Polyethylene pipes for water supply — Specification (<i>fifth revision</i>)
7328 : 2020	Specification for polyethylene material for moulding and extrusion (<i>second revision</i>)
12235 (Part 18) : 2004	Thermoplastic pipes and fittings — Method of test: Part 18 Determination of ring stiffness (<i>first revision</i>)
16268 : 2017/ ISO TR 10358 : 1993	Plastic pipes and fittings — Combined chemical-resistance classification table

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

3.1 Nominal Size (DN) — Numerical designation of the size of a component, other than a component

designated by a thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimetres (mm).

3.2 Nominal Size (DN/OD) — Nominal size related to the outside diameter.

3.3 Nominal Outside Diameter (d_n) — Specified outside diameter, in millimetres, assigned to a nominal size DN/OD.

3.4 Outside Diameter at any Point (d_o) — Value of the measurement of the outside diameter through its cross-section at any point of the pipe rounded to the next greater 0.1 mm.

3.5 Mean Outside Diameter (d_{em}) — Value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by ($\pi = 3.142$), rounded to the next greater 0.1 mm.

3.6 Minimum Mean Outside Diameter ($d_{em, Min}$) — Minimum value of the outside diameter as specified for a given nominal size.

3.7 Maximum Mean Outside Diameter ($d_{em, Max}$) — Maximum value of the outside diameter as specified for a given nominal size.

3.8 Out-of-roundness (Ovality) — Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross-section of the pipe, at 300 mm away from the cut end, for the pipe to be coiled.

3.9 Nominal Wall Thickness (e_n) — Numerical designation of the wall thickness of a pipe, which is a convenient round number approximately equal to the manufacturing dimension in millimetres.

3.10 Standard Dimension Ratio (SDR) — The ratio of the nominal outside diameter, d_n , of a pipe to its nominal wall thickness, e_n

$$SDR = d_n / e_n$$

3.11 Wall Thickness at any Point (e) — Wall thickness at any point of the body of the pipe, around its circumference.

3.11.1 Minimum Wall Thickness at any Point (e_{Min}) — Minimum value of the wall thickness at any point of the body of the pipe, around its circumference as specified.

3.11.2 Maximum Wall Thickness at any Point (e_{Max}) — Maximum value of the wall thickness at any point of the body of the pipe, around its circumference as specified.

3.12 Mean Wall Thickness (e_m) — The arithmetic mean of a number of measurements regularly spaced around the circumference of the pipe in the same cross-section of the pipe, including the measured minimum and the measured maximum values of the wall thickness.

3.13 Tolerance — Permissible variation of the specified value of a quantity expressed as the difference between the permissible maximum and permissible minimum values.

3.14 Minimum Required Strength (MRS) — Minimum value in megapascals (MPa), for long-term hydrostatic strength (LTHS) of the polyethylene resin which represents the 97.5 percent confidence limits of the predicted hydrostatic strength at 20 °C for 50 years. This is considered the property of the material.

3.15 Overall Service Design Coefficient (C) — An overall design co-efficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit.

3.16 Design Stress (σ) — The maximum allowable design stress expressed in megapascals (MPa), for a given application derived by dividing MRS by the overall service design coefficient.

NOTE — The maximum allowable design stress obtained as above is at an operating temperature of 20 °C.

3.17 Nominal Pressure (PN) — Numerical designation used for reference purposes related to the mechanical characteristics of the component of the piping system.

NOTE — The relationship between MRS, PN and SDR is given in Annex A of IS 4984.

3.18 Maximum Allowable Operating Pressure (MAOP) — The highest allowable continuous pressure expressed in MPa. It is given by the following equations:

$$P(bar) = \frac{20 (MRS)}{C \times [SDR - 1]}$$

or

$$P(MPa) = \frac{(2 \times \sigma)}{[SDR - 1]}$$

3.19 Melt Flow Rate (MFR) — Value relating to the viscosity of the molten thermoplastic material at a specified temperature and rate of shear.

3.20 Virgin Material — Thermoplastics material in a form such as granules which has not been previously processed other than for compounding and to which no reprocessed or recycled materials have been added.

3.21 Rework Material — Material prepared from rejected unused pipes, including trimmings from the production of pipes, that will be reprocessed in a manufacturer's plant by a process such as extrusion and for which the complete formulation is known.

4 GRADE OF RESIN

Pipes shall be classified according to the grade of the raw material (resin) as given in Table 1. The resin supplier shall give the raw material grade.

5 MATERIAL

5.1 General

The material used for the manufacture of pipes should not constitute toxic hazard, should not support microbial growth and should not give rise to unpleasant taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturer of raw material. The various constituents used to make the material for extrusion shall meet the requirements specified in 5.2 to 5.5.

5.2 Polyethylene Resin

5.2.1 PE resin used for the manufacture of pipes shall conform to parameters mentioned in Table 2. In addition, the resin shall conform to the requirements of 5.5 of IS 7328.

The material classification and conformity to Table 2 and 5.5 of IS 7328 shall be provided by raw material (resin) manufacturer with documentation duly certified by the resin manufacturer.

5.2.1.1 In case of pre-compounded black material, the PE resin shall meet the requirements in 5.2.1. The certificate for conformity in such a case shall additionally include the results of compound density, carbon black content, toluene extract, maximum volatile matter, carbon black particle size, ash content and carbon black dispersion to establish conformity to the requirements specified in SI No. (i) of Table 2, 8.3, SI No. (2), (3) and (4) of 5.3(d), 5.3(e) and 8.3, respectively. However, the base density should meet the requirement of Table 2, when calculated as per 5.4.7 of IS 7328.

5.3 Carbon Black Master Batch

Carbon black master batch shall be manufactured from a mixture of the following:

- a) Polyethylene, which may include co-polymers of ethylene and higher olefin, in which the higher olefin constituent does not exceed 10 percent (mass/mass) and density of 910-950 kg/m³;
- b) Loading of carbon black should not exceed 50 percent (*m/m*);
- c) Ash content < 0.1 percent; and
- d) Carbon black used in carbon black master batch shall comply with the following requirements:
 - 1) Density: 1.5 to 2.0 g/ml;
 - 2) Toluene extract not more than 0.1 percent (mass/mass);
 - 3) Maximum volatile matter 0.9 percent (*m/m*) (see Annex C of IS 4984); and
 - 4) Carbon black particle size should be less than 0.025 μ .

NOTE — A test report or confirmative certificate may be obtained from the carbon black master batch manufacturer.

5.4 Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin.

5.5 Rework Material

The addition of not more than 5 percent of the manufacturer's own rework material conforming to this standard is permissible. No other rework material shall be used.

6 PIPE DESCRIPTION

6.1 Pipes shall be designated according to the grade of material (see 6.1.1) followed by pressure rating (PN) (see 6.1.4), nominal outside diameter (DN) (see 6.1.3) and standard dimension ratio (SDR) (see 6.1.2). For example, PE 80, PN 4, DN 200, SDR 26 indicates pipe pertaining to material grade PE 80 and pressure rating 4, nominal outside diameter 200 mm with wall thickness corresponding to SDR 26.

6.1.1 The grade of material shall be as given in Table 1.

6.1.2 The standard dimension ratio of pipes covered in this standard are:

SDR 41, SDR 33, SDR 26, SDR 21, SDR 17, SDR 13.6, SDR 11, SDR 9, SDR 7.4 and SDR 6.

6.1.3 The nominal outside diameter of pipes covered in this standard are:

63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1 000, 1 200, 1 400, 1 600, 1 800, 2 000, 2 250 and 2 500 mm.

6.1.4 The pipes shall be classified by pressure rating (PN) corresponding to the maximum allowable operating pressure at 27 °C, as follows:

<i>Sl No.</i>	<i>Pressure Rating of Pipe</i>	<i>Maximum Allowable Operating Pressure at 27 °C</i>
(1)	(2)	(3)
i)	PN 2	0.20 MPa
ii)	PN 2.5	0.25 MPa
iii)	PN 3.2	0.32 MPa
iv)	PN 4	0.40 MPa
v)	PN 5	0.50 MPa
vi)	PN 6	0.60 MPa
vii)	PN 8	0.80 MPa
viii)	PN 10	1.00 MPa
ix)	PN 12.5	1.25 MPa
x)	PN 16	1.60 MPa
xi)	PN 20	2.00 MPa

The pressure rating for PE pipes for various material grades and SDR shall be as given in Table 4 of IS 4984.

Table 1 Classification of Materials
(Clauses 4 and 6.1.1)

SI No.	Material Classification (Grade)	MRS of PE Resin at 20 °C for 50 Years Life	Design Stress at 20 °C
		MPa	MPa
(1)	(2)	(3)	(4)
i)	PE 63	6.3	5.0
ii)	PE 80	8.0	6.3
iii)	PE 100	10.0	8.0
NOTES			
1 The pipes are recommended for maximum liquid temperature of 60 °C (<i>see</i> Annex B).			
2 The pipes may also be used up to the ambient temperature of –40 °C without any correction factor as long as the fluid temperatures inside the pipe do not exceed the design temperatures for which the pipes are designed for. Intermittent increase in the ambient or fluid temperatures because of weather changes would not have any deleterious effect on the pipe's long-term performance.			

Table 2 Characteristics of PE Resin as Granules
(Clauses 5.2.1 and 5.2.1.1)

SI No.	Characteristics	Unit	Requirements	Test Parameters	Test Method
(1)	(2)	(3)	(4)	(5)	(6)
i)	Base density	kg/m ³	940-960 (The tested value of density shall not differ from density declared/nominated by the resin manufacturer by more than 3 kg/m ³ .)	27 °C	IS 7328
ii)	Melt flow rate ¹⁾	g /10 min	0.15 to 1.1 (both inclusive) (The tested value of MFR shall be within ± 20 percent of the MFR declared/nominated by the resin manufacturer if the latter is 1 or above, and within ± 30 percent if the latter is less than 1.)	190 °C using a 5 kg mass	IS 2530
iii)	Thermal stability (oxidation induction time)	min	≥ 20	200 °C, isothermal	Annex B of IS 4984
iv)	Volatile matter	mg/kg	≤ 350	Number of tests pieces	01 Annex C of IS 4984
v)	Water content ²⁾	mg/kg	≤ 300	Number of tests pieces	01 Annex D of IS 4984

¹⁾ In case of materials with $0.15 \leq \text{MFR} < 0.20$, attention is drawn to the fusion compatibility which has to be established by the raw material supplier. The lowest MFR value resulting from the maximum lower deviation of the nominated value should not be less than 0.15. For $0.15 \leq \text{MFR} < 0.20$ compounds, fusion compatibility of larger diameter thicker-walled pipes should be investigated to confirm compatibility. If electrofusion jointing is to be adopted, appropriate testing should be carried out to verify the fusion capability of such pipes.

²⁾ The requirement is only applicable if the measured volatile content is not in conformity with its specified requirement. In case of dispute, the requirement for water content shall apply (If the water content exceeds the limit, drying to be done prior to use).

6.1.4.1 Calculation of maximum allowable operating pressure at temperatures other than 27 °C

For design purpose, the maximum allowable operating pressures shall be derived for temperatures other than 27 °C and different life expectancy (other than 50 years) based on time to failure curves established using the following equation:

$$\log(t) = A + \frac{C}{T} + D \times (\log \sigma)$$

where,

- σ = induced hydrostatic stress, in MPa;
- A, C and D = coefficients for determining time to failure curve, as given in the table below or as provided by the pipe manufacturer based on the values declared by the resin supplier;
- T = temperature, in °K; and
- t = time to failure, in h.

The coefficients for determining time to failure curve for various material grades should be as given below:

Sl No.	Material	Coefficients		
		A	C	D
(1)	(2)	(3)	(4)	(5)
i)	PE 63	– 41.417 3	22 008.572 2	–35.098 7
ii)	PE 80	–42.548 8	24 074.8	–37.575 8
iii)	PE 100	–45.400 8	28 444.73	–45.989 0

If any material does not obey the curves with these coefficients, it is the responsibility of the user and the design engineer to get the values of maximum allowable operating pressure from raw material manufacturer with coefficients obtained for their material for various temperatures and years of life.

The maximum allowable operating pressure for different operating temperatures and life expectancies as given in Annex B are based on A, C and D values given in the above table, and are provided for guidance only.

6.2 Colour

The colour of the pipe shall be black.

7 GEOMETRIC CHARACTERISTICS OF PIPE

7.1 Visual Appearance

The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects. The ends of the pipes shall be cleanly cut square with the

axis of the pipe to within the tolerances given in Table 3 and free from deformity. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible, provided that the wall thickness remains within permissible limits.

Table 3 Maximum Out-of-Roundness of Pipe End
(Clause 7.1)

Sl No.	Nominal Diameter, DN	Maximum Out of Square of Pipe End
	mm	mm
(1)	(2)	(3)
i)	63 and 75	2
ii)	90 to 125	3
iii)	140 to 180	4
iv)	200 to 280	5
v)	280 to 500	7
vi)	500 to 1 000	9
vii)	Above 1 000	12

7.2 Length

The length of straight pipe shall be 3 m to 20 m as agreed between the manufacturer and the purchaser.

7.3 Coiling

The pipes shall be coiled such that localized deformation, for example, buckling and kinking is prevented. The minimum internal diameter of the coil shall not be less than $18 d_n$. The length of the coiled pipes shall be as agreed between the manufacturer and the purchaser.

7.4 Dimensions

The mean outside diameter, d_{em} , and the out-of-roundness (ovality) of the pipes for different nominal diameters covered in the standard when measured in accordance with 7.4.1.1 and 7.4.1.2 of IS 4984 respectively, shall meet the requirements specified in Table 3 of IS 4984. The minimum and maximum wall thickness of pipes when measured in accordance with 7.4.1.1 of IS 4984, shall meet the requirements specified in Table 4 of IS 4984.

NOTE — In the case of dispute, the dimension of pipes shall be measured after conditioning at room temperature for 4 h.

8 PERFORMANCE REQUIREMENTS

8.1 Hydraulic Characteristics

8.1.1 Internal Pressure Creep Rupture Test

When subjected to internal pressure creep rupture test in accordance with procedure given in Annex E of IS 4984 and test parameters as specified in Table 4, the pipes under test shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period.

Table 4 Hydraulic Characteristic Requirements of Pipes

(Clauses 8.1.1 and 8.1.2)

Sl No.	Test Temperature °C	Test Duration h	Induced Hoop Stress MPa		
			PE 63	PE 80	PE 100
(1)	(2)	(3)	(4)	(5)	(6)
i)	27	100	6.9	8.6	10.7
ii)	80	48	3.8	4.9	5.7
iii)	80	165	3.5	4.5	5.4
iv)	80	1 000	3.2	4.0	5.0

8.1.2 Internal Pressure Creep Rupture Test of Pipe Joints

The pipe joints shall also be tested for hydraulic characteristics requirement by subjecting the butt fusion joint or electro fusion joints of a pipe to internal pressure creep rupture test at 80 °C for 48 h as per Table 4 and in accordance with the method given in Annex E of IS 4984. The pipe joints under test shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period.

8.2 Longitudinal Reversion Test

When tested in accordance with the method given in Annex F of IS 4984, the value of the longitudinal reversion shall not be greater than 3 percent.

8.3 Carbon Black Content and Dispersion

When tested from a composite sample of minimum three pipes, in accordance with IS 2530, the carbon black content shall be within 2.5 ± 0.5 percent. When tested from a composite sample of minimum three

pipes, the carbon black dispersion shall meet the requirement of 5.4.6 of IS 7328.

8.4 Melt Flow Rate

When tested from a composite sample of minimum three pipes as per IS 2530 at 190 °C with nominal load of 5 kgf, MFR shall not deviate from the MFR of the resin by more than 30 percent.

8.5 Oxidation Induction Time

The minimum oxidation induction time of the pipe when tested in accordance with the method given in Annex B of IS 4984 shall be not less than 20 min.

8.6 Density

When tested from a composite sample of minimum three pipes as per IS 7328, the base (corrected) density of pipes shall be between 940 kg/m³ and 960 kg/m³ and the same shall not differ from the density of the resin as declared/nominated by the resin manufacturer by more than 3 kg/m³.

8.7 Tensile Strength for Butt-fusion

When tested according to Annex G of IS 4984, the test specimens prepared by punching/machining from pipe butt fusion sample preferably 110 mm diameter and SDR 11 shall show ductile failure. If the sample shows brittle failure, the test may be considered as a failure.

NOTE — If 110 mm and SDR 11 pipes are not being manufactured, test shall be carried out on the nearest, preferably higher size of SDR 11 being manufactured. If pipe sizes only below 90 mm are manufactured, the test is not required, however, in such cases, a test certificate from the raw material (resin) supplier for establishing conformity to the above requirement for 110 mm SDR 11 pipe shall be provided.

Table 5 Elongation at Break Requirements of Pipes

(Clause 8.8)

Sl No.	Characteristics		Requirements	Test Parameters		Test Method Refer to
				Parameter	Value	
(1)	(2)	(3)		(4)	(5)	(6)
i)	Elongation at break for $e \leq 5$ mm	Yield strength : 15 MPa, <i>Min</i>		Test piece shape	Type 2	Annex H of IS 4984
		Elongation at break : 350 percent, <i>Min</i>		Test speed	100 mm/min	
ii)	Elongation at break for $5 \text{ mm} < e \leq 12$ mm	Yield strength : 15 MPa, <i>Min</i>		Test piece shape	Type 1 ¹⁾	Annex H of IS 4984
		Elongation at break : 350 percent, <i>Min</i>		Test speed	50 mm/min	
iii)	Elongation at break for $e > 12$ mm	Yield strength : 15 MPa, <i>Min</i>		Test piece shape	Type 1 ¹⁾	Annex H of IS 4984
		Elongation at break : 350 percent, <i>Min</i>		Test speed	25 mm/min	
or						
				Test piece shape	Type 3 ¹⁾	
				Test speed	10 mm/min	
¹⁾ Where practical, machined type 2 test pieces may be used for pipe wall thickness ≤ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.						

¹⁾ Where practical, machined type 2 test pieces may be used for pipe wall thickness ≤ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

8.8 Tensile Properties

When tested according to Annex H of IS 4984 with test parameters as given in Table 5, the test specimens punched/machined from pipe samples, shall meet the requirements given in *col 3* of Table 5.

8.9 Slow Crack Growth Rate

8.9.1 When subjected to test parameters as given below and tested in accordance with the procedure given in Annex E of IS 4984, the notched test specimens prepared from 110 mm SDR 11 pipe in accordance with Annex J of IS 4984 shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period.

Sl. No	Test Temperature °C	Test Duration h	Internal Test Pressure, Min (or Induced Hoop Stress, Min)		
			MPa		
			PE 63	PE 80	PE 100
(1)	(2)	(3)	(4)	(5)	(6)
i)	80 ± 1	500	0.64 (3.2)	0.8 (4.0)	0.92 (4.6)

8.9.1.1 If 110 mm SDR 11 pipes are not being manufactured, the test shall be carried out on the nearest higher size SDR 11 pipe being manufactured with test parameters as given in **8.9.1**.

NOTES

1 The test is applicable to pipes of wall thickness greater than 5 mm.

2 If pipe sizes only below 63 mm are manufactured, the test is not required, however, in such cases, the test certificate from the raw material (resin) supplier for establishing conformity to the above requirement for 110 mm SDR 11 pipe will suffice.

3 In case SDR 11 pipes are not manufactured, the internal test pressure values shall be calculated using the formula given in **3.18** (considering pressure reduction coefficient, f_T as 1) for an induced hoop stress of 3.2 MPa, 4.0 MPa and 4.6 MPa for PE 63, PE 80 and PE 100 pipes, respectively.

9 SAMPLING, FREQUENCY OF TESTS AND CRITERIA FOR CONFORMITY

9.1 Type Tests

9.1.1 Type tests are intended to prove the suitability and performance of a new composition, a new technique or a new size of a pipe. Such tests, therefore, need to be applied only when a change is made in polymer composition or method of manufacturer, or when a new size of pipe is to be introduced. Even if no change is envisaged, type test shall be done at least once during the validity period as mentioned in **9.1.5**.

9.1.2 For each of the type test, three samples of pipes of same grade, same size, same SDR and same pressure

rating shall be selected at random from the regular production lot and shall be tested for compliance with the requirements of the type test as given in Table 6.

Table 6 Type Tests

(Clause 9.1.2)

Sl No.	Description of Test	Sample Size	Requirement Clause
(1)	(2)	(3)	(4)
i)	Tensile strength for butt fusion	3	8.7
ii)	Fusion compatibility test: Internal pressure creep rupture test (hydrostatic resistance test) for joints at 80 °C for 48 h	3	8.1.2
iii)	Internal pressure creep rupture test (hydrostatic resistance test) at 27 °C for 100 h	3	8.1.1
iv)	Internal pressure creep rupture test (hydrostatic resistance test) at 80 °C for 165 h	3	8.1.1
v)	Internal pressure creep rupture test (hydrostatic resistance test) at 80 °C for 1 000 h	3	8.1.1
vi)	Slow crack growth rate test	3	8.9

9.1.3 If all the samples pass the requirements of the type test, the type of the pipe under consideration shall be considered eligible for type approval.

9.1.4 In case any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test again. If in repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

9.1.5 At the end of the validity period [normally one year for internal pressure creep rupture test at 27 °C for 100 h and internal pressure creep rupture test (hydrostatic resistance test) for joints at 80 °C for 48 h, five years for internal pressure creep rupture test (hydrostatic resistance test) at 80 °C for 1 000 h, and two years for all other type tests] or earlier as may be necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

9.2 Acceptance Tests

9.2.1 Acceptance tests are carried out on sample selected from a lot for the purpose of acceptance of the lot.

9.2.2 Lot

All pipes of the same size, same SDR and same grade and also manufactured essentially under similar conditions of manufacture shall constitute a lot. For ascertaining conformity of the lot to the requirements of this standard, samples for acceptance test shall be selected and tested for compliance as per Table 7.

9.2.3 Conformity to Dimensional and Visual Characteristics

9.2.3.1 The number of test samples shall be in accordance with Table 8.

9.2.3.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS 4905 may be referred. For the above purpose, each length of the coil of a given size, grade and SDR shall be considered as one pipe. In the absence of a random number table, the following procedure may be adopted.

Starting from any pipe in the lot, count them as 1, 2, 3, 4, etc., up to r and so on where r is the integral part of N/n , N being the number of pipes in the lot and n is the number of pipes in the samples. Every r^{th} pipe so counted shall be drawn so as to constitute the required sample size.

9.2.3.3 The number of pipes given for the first sample in col 4 of Table 8 shall be examined for visual and dimensional requirements given in 7.1 and 7.4. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed

to have satisfied these requirements, if the number of defectives found in the first sample are less than or equal to the corresponding acceptance number given in col 6 of Table 8. The lot shall be deemed not to have met these requirements if the number of defectives found in the first sample is greater than or equal to the corresponding rejection numbers given in col 7 of Table 8. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in col 6 and col 7 of Table 8, the second sample of the size given in col 4 of Table 8 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 6 of Table 8 otherwise not. In case, the sample size is equal or less than, lot size, 100 percent inspection shall be done for these tests and all the samples from the lot which pass these tests shall be tested for other acceptance tests.

9.2.4 Conformity to Acceptance Tests Other than Dimensional and Visual Characteristics

The lot having satisfied dimensional and visual requirements shall be tested for other acceptance tests as given in Table 7. The number of test samples selected from the lot for subjecting to these tests shall be in accordance with Table 9. For the above purpose, each length of the coil of a given size, grade and SDR shall be considered as one pipe. The lot shall be considered to have met the requirements of these tests, if none of samples tested fails.

Table 7 Acceptance Tests

(Clauses 9.2.2 and 9.2.4)

Sl No.	Description of Test	Sample Size	Requirement Clause
(1)	(2)	(3)	(4)
i)	Visual appearance and dimensions	Table 17	7.1 and 7.4
ii)	Melt flow rate	Table 18	8.4
iii)	Density	Table 18	8.6
iv)	Reversion test	Table 18	8.2
v)	Elongation at break	Table 18	8.8
vi)	Carbon black content	Table 18	8.3
vii)	Carbon black dispersion	Table 18	8.3
viii)	Oxidation induction	Table 18	8.5
ix)	Internal pressure creep rupture test (hydrostatic resistance test at 80°C for 48 h)	Table 18	8.1.1

Table 8 Scale of Sampling for Visual and Dimensional Requirements
(Clauses 9.2.3.1 and 9.2.3.3)

Sl No.	No. of Pipes in the Lot	Sample No.	Sample Size	Cumulative Sample Size	Acceptance No.	Rejection No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Up to 1 000	First	13	13	0	2
		Second	13	26	1	2
ii)	1 001 to 2 700	First	20	20	0	2
		Second	20	40	1	2
iii)	2 701 to 10 000	First	32	32	1	3
		Second	32	64	3	4
iv)	10 001 and above	First	50	50	1	4
		Second	50	100	4	5

Table 9 Scale of Sampling for Acceptance Tests Other than Visual and Dimensional Requirements
(Clause 9.2.4)

Sl No.	No. of Pipes in the Lot	Sample Size for Tests other than Hydraulic Characteristics	Sample Size for Hydraulic Characteristics for Sizes up to 315 mm OD	Sample Size for Hydraulic Characteristics for Sizes greater than 315 mm OD
(1)	(2)	(3)	(4)	(5)
i)	Up to 1 000	3	2	1
ii)	1 001 to 2 700	5	3	2
iii)	2 701 to 10 000	7	4	3
iv)	10 001 and above	8	5	4

10 MARKING

10.1 Each straight length/coil of pipe shall be clearly and indelibly marked in white/yellow colour using ink/paint or inkjet print or hot embossed on white base, at every 1 m throughout the length of pipe/coil with the information given in **10.1.1**.

10.1.1 The marking on the pipe shall carry the following minimum information:

- Manufacture's name/trade-mark;
- Pipe designation as per **6.1**; and
- Lot number/Batch number containing information of date of manufacture.

10.1.1.2 The lot number/batch number shall include the details of production in the following manner:

Year	Month	Day	Machine No.	Shift
XXXX	XX	XX	XXX	X

10.2 BIS Certification Marking

PE pipe/coil for sewerage and industrial chemicals and effluent conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and each pipe/coil may be marked with the Standard Mark.

ANNEX A

(Clause 1.6)

STIFFNESS PROPERTIES OF POLYETHYLENE PIPES

A-1 The stiffness properties of different pipes for various SDR and grade of material, at 27 °C are given below for guidance only:

Sl No.	Grade of Material, Pipe Standard Dimension Ratio (SDR) and Corresponding Stiffness										
	Grade ↓	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	PE 63	1.0	2.0	4.0	8.0	16.0	33.0	66.0	130.0	254.0	533.0
ii)	PE 80	1.0	2.0	5.0	9.0	17.0	35.0	70.0	138.0	270.0	566.0
iii)	PE 100	1.0	3.0	6.0	11.0	22.0	46.0	91.0	179.0	349.0	733.0

Stiffness is calculated using the following formula:

$$SN = E \times \frac{10^6}{12 \times (SDR - 1)^3}$$

where

SN = ring stiffness, in kN/m^2 ;

E = Young's modulus, in MPa, (800 MPa for PE 63, 850 MPa for PE 80 and 1 100 MPa for PE 100); and

SDR = standard dimension ratio.

A-2 Generally, there is reduction in stiffness by 25 percent for every rise in temperature of 10 °C. Whereas for temperatures lower than 27 °C, the stiffness of PE pipes will increase. Wherever desired by the purchaser, the pipe manufacturer shall obtain the stiffness class of pipes for temperatures other than 27 °C from the resin supplier and provide the same to the purchaser.

ANNEX B

(Clause 6.1.4.1)

MAXIMUM ALLOWABLE OPERATING PRESSURES

B-1 The maximum allowable operating pressures given in Tables 10 to 18 are for guidance only, and have been calculated using coefficients, A, C and D as given in **6.1.4.1**.

**Table 10 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 63,
and Overall Service (Design) Coefficient 1.25**

(Clause B-1)

Sl No.	Temperature °C	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
Maximum Allowable Operating Pressure MPa												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	3.2	4.0	5.1	6.4	8.0	10.2	12.8	16.0	20.0	25.6
ii)	10	10	3.1	3.9	5.0	6.3	7.9	10.0	12.6	15.7	19.6	25.1
iii)	10	25	3.1	3.8	4.9	6.1	7.6	9.7	12.2	15.3	19.1	24.5
iv)	10	50	3.0	3.7	4.8	6.0	7.5	9.5	12.0	15.0	18.7	24.0
v)	10	100	2.9	3.7	4.7	5.9	7.4	9.3	11.8	14.7	18.4	23.5
vi)	20	5	2.7	3.4	4.3	5.4	6.7	8.5	10.8	13.5	16.8	21.5
vii)	20	10	2.6	3.3	4.2	5.3	6.6	8.4	10.6	13.2	16.5	21.1
viii)	20	25	2.6	3.2	4.1	5.1	6.4	8.2	10.3	12.9	16.1	20.6
ix)	20	50	2.5	3.1	4.0	5.0	6.3	8.0	10.1	12.6	15.7	20.2
x)	20	100	2.5	3.1	4.0	4.9	6.2	7.8	9.9	12.4	15.4	19.8
xi)	27	5	2.3	2.9	3.7	4.6	5.7	7.3	9.1	11.4	14.3	18.3
xii)	27	10	2.2	2.8	3.6	4.5	5.6	7.1	9.0	11.2	14.0	17.9
xiii)	27	25	2.2	2.7	3.5	4.4	5.5	6.9	8.7	10.9	13.7	17.5
xiv)	27	50	2.1	2.7	3.4	4.3	5.4	6.8	8.6	10.7	13.4	17.1
xv)	40	5	2.0	2.5	3.1	3.9	4.9	6.2	7.9	9.8	12.3	15.7
xvi)	40	10	1.9	2.4	3.1	3.9	4.8	6.1	7.7	9.6	12.0	15.4
xvii)	40	25	1.9	2.3	3.0	3.8	4.7	6.0	7.5	9.4	11.7	15.0
xviii)	40	50	1.8	2.3	2.9	3.7	4.6	5.8	7.4	9.2	11.5	14.7
xix)	50	5	1.7	2.1	2.7	3.4	4.3	5.4	6.8	8.5	10.6	13.6
xx)	50	10	1.7	2.1	2.7	3.3	4.2	5.3	6.7	8.3	10.4	13.4
xxi)	50	15	1.7	2.1	2.6	3.3	4.1	5.2	6.6	8.3	10.3	13.2
xxii)	60	5	1.5	1.9	2.4	3.0	3.7	4.7	6.0	7.4	9.3	11.9

**Table 11 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 63,
and Overall Service (Design) Coefficient 1.6**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	2.5	3.1	4.0	5.0	6.3	7.9	10.0	12.5	15.6	20.0
ii)	10	10	2.5	3.1	3.9	4.9	6.1	7.8	9.8	12.3	15.3	19.6
iii)	10	25	2.4	3.0	3.8	4.8	6.0	7.6	9.6	11.9	14.9	19.1
iv)	10	50	2.3	2.9	3.7	4.7	5.9	7.4	9.4	11.7	14.6	18.7
v)	10	100	2.3	2.9	3.7	4.6	5.7	7.3	9.2	11.5	14.4	18.4
vi)	20	5	2.1	2.6	3.4	4.2	5.3	6.7	8.4	10.5	13.1	16.8
vii)	20	10	2.1	2.6	3.3	4.1	5.2	6.5	8.2	10.3	12.9	16.5
viii)	20	25	2.0	2.5	3.2	4.0	5.0	6.4	8.0	10.0	12.6	16.1
ix)	20	50	2.0	2.5	3.1	3.9	4.9	6.2	7.9	9.8	12.3	15.7
x)	20	100	1.9	2.4	3.1	3.9	4.8	6.1	7.7	9.7	12.1	15.4
xi)	27	5	1.8	2.2	2.9	3.6	4.5	5.7	7.1	8.9	11.2	14.3
xii)	27	10	1.8	2.2	2.8	3.5	4.4	5.6	7.0	8.8	10.9	14.0
xiii)	27	25	1.7	2.1	2.7	3.4	4.3	5.4	6.8	8.5	10.7	13.7
xiv)	27	50	1.7	2.1	2.7	3.3	4.2	5.3	6.7	8.4	10.5	13.4
xv)	40	5	1.5	1.9	2.5	3.1	3.8	4.9	6.1	7.7	9.6	12.3
xvi)	40	10	1.5	1.9	2.4	3.0	3.8	4.8	6.0	7.5	9.4	12.0
xvii)	40	25	1.5	1.8	2.3	2.9	3.7	4.7	5.9	7.3	9.2	11.7
xviii)	40	50	1.4	1.8	2.3	2.9	3.6	4.6	5.7	7.2	9.0	11.5
xix)	50	5	1.3	1.7	2.1	2.7	3.3	4.2	5.3	6.7	8.3	10.6
xx)	50	10	1.3	1.6	2.1	2.6	3.3	4.1	5.2	6.5	8.2	10.4
xxi)	50	15	1.3	1.6	2.1	2.6	3.2	4.1	5.2	6.4	8.1	10.3
xxii)	60	5	1.2	1.5	1.9	2.3	2.9	3.7	4.7	5.8	7.3	9.3

**Table 12 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 63,
and Overall Service (Design) Coefficient 2.0**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	2.0	2.5	3.2	4.0	5.0	6.4	8.0	10.0	12.5	16.0
ii)	10	10	2.0	2.5	3.1	3.9	4.9	6.2	7.9	9.8	12.3	15.7
iii)	10	25	1.9	2.4	3.1	3.8	4.8	6.1	7.6	9.6	11.9	15.3
iv)	10	50	1.9	2.3	3.0	3.7	4.7	6.0	7.5	9.4	11.7	15.0
v)	10	100	1.8	2.3	2.9	3.7	4.6	5.8	7.4	9.2	11.5	14.7
vi)	20	5	1.7	2.1	2.7	3.4	4.2	5.3	6.7	8.4	10.5	13.5
vii)	20	10	1.6	2.1	2.6	3.3	4.1	5.2	6.6	8.2	10.3	13.2
viii)	20	25	1.6	2.0	2.6	3.2	4.0	5.1	6.4	8.0	10.0	12.9
ix)	20	50	1.6	2.0	2.5	3.1	3.9	5.0	6.3	7.9	9.8	12.6
x)	20	100	1.5	1.9	2.5	3.1	3.9	4.9	6.2	7.7	9.7	12.4
xi)	27	5	1.4	1.8	2.3	2.9	3.6	4.5	5.7	7.1	8.9	11.4
xii)	27	10	1.4	1.8	2.2	2.8	3.5	4.4	5.6	7.0	8.8	11.2
xiii)	27	25	1.4	1.7	2.2	2.7	3.4	4.3	5.5	6.8	8.5	10.9
xiv)	27	50	1.3	1.7	2.1	2.7	3.3	4.2	5.4	6.7	8.4	10.7
xv)	40	5	1.2	1.5	2.0	2.5	3.1	3.9	4.9	6.1	7.7	9.8
xvi)	40	10	1.2	1.5	1.9	2.4	3.0	3.8	4.8	6.0	7.5	9.6
xvii)	40	25	1.2	1.5	1.9	2.3	2.9	3.7	4.7	5.9	7.3	9.4
xviii)	40	50	1.1	1.4	1.8	2.3	2.9	3.6	4.6	5.7	7.2	9.2
xix)	50	5	1.1	1.3	1.7	2.1	2.7	3.4	4.3	5.3	6.7	8.5
xx)	50	10	1.0	1.3	1.7	2.1	2.6	3.3	4.2	5.2	6.5	8.3
xxi)	50	15	1.0	1.3	1.7	2.1	2.6	3.3	4.1	5.2	6.4	8.3
xxii)	60	5	0.9	1.2	1.5	1.9	2.3	3.0	3.7	4.7	5.8	7.4

**Table 13 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 80,
and Overall Service (Design) Coefficient 1.25**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	4.1	5.1	6.5	8.2	10.2	12.9	16.3	20.4	25.5	32.6
ii)	10	10	4.0	5.0	6.4	8.0	10.0	12.7	16.0	20.0	25.0	32.0
iii)	10	25	3.9	4.9	6.2	7.8	9.8	12.4	15.6	19.5	24.4	31.2
iv)	10	50	3.8	4.8	6.1	7.7	9.6	12.2	15.3	19.2	24.0	30.7
v)	10	100	3.8	4.7	6.0	7.5	9.4	11.9	15.1	18.8	23.5	30.1
vi)	20	5	3.4	4.3	5.5	6.8	8.5	10.8	13.6	17.1	21.3	27.3
vii)	20	10	3.3	4.2	5.4	6.7	8.4	10.6	13.4	16.7	20.9	26.8
viii)	20	25	3.3	4.1	5.2	6.5	8.2	10.4	13.1	16.3	20.4	26.1
ix)	20	50	3.2	4.0	5.1	6.4	8.0	10.2	12.8	16.0	20.1	25.7
x)	20	100	3.1	3.9	5.0	6.3	7.9	10.0	12.6	15.7	19.7	25.2
xi)	27	5	2.9	3.6	4.6	5.8	7.2	9.2	11.6	14.4	18.1	23.1
xii)	27	10	2.8	3.5	4.5	5.7	7.1	9.0	11.3	14.2	17.7	22.7
xiii)	27	25	2.8	3.5	4.4	5.5	6.9	8.8	11.1	13.8	17.3	22.1
xiv)	27	50	2.7	3.4	4.3	5.4	6.8	8.6	10.9	13.6	17.0	21.7
xv)	40	5	2.5	3.1	4.0	4.9	6.2	7.8	9.9	12.4	15.5	19.8
xvi)	40	10	2.4	3.0	3.9	4.9	6.1	7.7	9.7	12.1	15.2	19.4
xvii)	40	25	2.4	3.0	3.8	4.7	5.9	7.5	9.5	11.8	14.8	19.0
xviii)	40	50	2.3	2.9	3.7	4.7	5.8	7.4	9.3	11.6	14.5	18.6
xix)	50	5	2.1	2.7	3.4	4.3	5.3	6.8	8.5	10.7	13.4	17.1
xx)	50	10	2.1	2.6	3.4	4.2	5.2	6.7	8.4	10.5	13.1	16.8
xxi)	50	15	2.1	2.6	3.3	4.2	5.2	6.6	8.3	10.4	13.0	16.6
xxii)	60	5	1.9	2.3	3.0	3.7	4.7	5.9	7.5	9.3	11.6	14.9

**Table 14 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 80,
and Overall Service (Design) Coefficient 1.6**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	3.2	4.0	5.1	6.4	8.0	10.1	12.7	15.9	19.9	25.5
ii)	10	10	3.1	3.9	5.0	6.3	7.8	9.9	12.5	15.6	19.5	25.0
iii)	10	25	3.1	3.8	4.9	6.1	7.6	9.7	12.2	15.3	19.1	24.4
iv)	10	50	3.0	3.7	4.8	6.0	7.5	9.5	12.0	15.0	18.7	24.0
v)	10	100	2.9	3.7	4.7	5.9	7.3	9.3	11.8	14.7	18.4	23.5
vi)	20	5	2.7	3.3	4.3	5.3	6.7	8.5	10.7	13.3	16.7	21.3
vii)	20	10	2.6	3.3	4.2	5.2	6.5	8.3	10.5	13.1	16.4	20.9
viii)	20	25	2.6	3.2	4.1	5.1	6.4	8.1	10.2	12.8	16.0	20.4
ix)	20	50	2.5	3.1	4.0	5.0	6.3	8.0	10.0	12.5	15.7	20.1
x)	20	100	2.5	3.1	3.9	4.9	6.2	7.8	9.8	12.3	15.4	19.7
xi)	27	5	2.3	2.8	3.6	4.5	5.6	7.2	9.0	11.3	14.1	18.1
xii)	27	10	2.2	2.8	3.5	4.4	5.5	7.0	8.9	11.1	13.8	17.7
xiii)	27	25	2.2	2.7	3.5	4.3	5.4	6.9	8.6	10.8	13.5	17.3
xiv)	27	50	2.1	2.7	3.4	4.2	5.3	6.7	8.5	10.6	13.3	17.0
xv)	40	5	1.9	2.4	3.1	3.9	4.8	6.1	7.7	9.7	12.1	15.5
xvi)	40	10	1.9	2.4	3.0	3.8	4.7	6.0	7.6	9.5	11.9	15.2
xvii)	40	25	1.9	2.3	3.0	3.7	4.6	5.9	7.4	9.3	11.6	14.8
xviii)	40	50	1.8	2.3	2.9	3.6	4.5	5.8	7.3	9.1	11.4	14.5
xix)	50	5	1.7	2.1	2.7	3.3	4.2	5.3	6.7	8.3	10.4	13.4
xx)	50	10	1.6	2.0	2.6	3.3	4.1	5.2	6.6	8.2	10.2	13.1
xxi)	50	15	1.6	2.0	2.6	3.2	4.1	5.1	6.5	8.1	10.1	13.0
xxii)	60	5	1.5	1.8	2.3	2.9	3.6	4.6	5.8	7.3	9.1	11.6

**Table 15 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 80,
and Overall Service (Design) Coefficient 2.0**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	2.5	3.2	4.1	5.1	6.4	8.1	10.2	12.7	15.9	20.4
ii)	10	10	2.5	3.1	4.0	5.0	6.3	7.9	10.0	12.5	15.6	20.0
iii)	10	25	2.4	3.1	3.9	4.9	6.1	7.7	9.8	12.2	15.3	19.5
iv)	10	50	2.4	3.0	3.8	4.8	6.0	7.6	9.6	12.0	15.0	19.2
v)	10	100	2.4	2.9	3.8	4.7	5.9	7.5	9.4	11.8	14.7	18.8
vi)	20	5	2.1	2.7	3.4	4.3	5.3	6.8	8.5	10.7	13.3	17.1
vii)	20	10	2.1	2.6	3.3	4.2	5.2	6.6	8.4	10.5	13.1	16.7
viii)	20	25	2.0	2.6	3.3	4.1	5.1	6.5	8.2	10.2	12.8	16.3
ix)	20	50	2.0	2.5	3.2	4.0	5.0	6.4	8.0	10.0	12.5	16.0
x)	20	100	2.0	2.5	3.1	3.9	4.9	6.2	7.9	9.8	12.3	15.7
xi)	27	5	1.8	2.3	2.9	3.6	4.5	5.7	7.2	9.0	11.3	14.4
xii)	27	10	1.8	2.2	2.8	3.5	4.4	5.6	7.1	8.9	11.1	14.2
xiii)	27	25	1.7	2.2	2.8	3.5	4.3	5.5	6.9	8.6	10.8	13.8
xiv)	27	50	1.7	2.1	2.7	3.4	4.2	5.4	6.8	8.5	10.6	13.6
xv)	40	5	1.5	1.9	2.5	3.1	3.9	4.9	6.2	7.7	9.7	12.4
xvi)	40	10	1.5	1.9	2.4	3.0	3.8	4.8	6.1	7.6	9.5	12.1
xvii)	40	25	1.5	1.9	2.4	3.0	3.7	4.7	5.9	7.4	9.3	11.8
xviii)	40	50	1.5	1.8	2.3	2.9	3.6	4.6	5.8	7.3	9.1	11.6
xix)	50	5	1.3	1.7	2.1	2.7	3.3	4.2	5.3	6.7	8.3	10.7
xx)	50	10	1.3	1.6	2.1	2.6	3.3	4.2	5.2	6.6	8.2	10.5
xxi)	50	15	1.3	1.6	2.1	2.6	3.2	4.1	5.2	6.5	8.1	10.4
xxii)	60	5	1.2	1.5	1.9	2.3	2.9	3.7	4.7	5.8	7.3	9.3

**Table 16 Maximum Allowable Operating Pressure for Pipes of Material Grade PE 100,
and Overall Service (Design) Coefficient 1.25**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	5.0	6.3	8.0	10.0	12.5	15.9	20.0	25.0	31.3	40.0
ii)	10	10	4.9	6.2	7.9	9.9	12.3	15.7	19.7	24.7	30.8	39.4
iii)	10	25	4.8	6.0	7.7	9.7	12.1	15.3	19.3	24.2	30.2	38.7
iv)	10	50	4.8	6.0	7.6	9.5	11.9	15.1	19.0	23.8	29.8	38.1
v)	10	100	4.7	5.9	7.5	9.4	11.7	14.9	18.8	23.5	29.3	37.5
vi)	20	5	4.2	5.3	6.7	8.4	10.5	13.4	16.9	21.1	26.3	33.7
vii)	20	10	4.2	5.2	6.6	8.3	10.4	13.2	16.6	20.8	26.0	33.2
viii)	20	25	4.1	5.1	6.5	8.1	10.2	12.9	16.3	20.4	25.4	32.6
ix)	20	50	4.0	5.0	6.4	8.0	10.0	12.7	16.0	20.0	25.1	32.1
x)	20	100	3.9	4.9	6.3	7.9	9.9	12.5	15.8	19.7	24.7	31.6
xi)	27	5	3.6	4.5	5.7	7.2	9.0	11.4	14.4	18.0	22.4	28.7
xii)	27	10	3.5	4.4	5.7	7.1	8.8	11.2	14.1	17.7	22.1	28.3
xiii)	27	25	3.5	4.3	5.5	6.9	8.7	11.0	13.9	17.3	21.7	27.7
xiv)	27	50	3.4	4.3	5.5	6.8	8.5	10.8	13.7	17.1	21.3	27.3
xv)	40	5	3.1	3.9	4.9	6.2	7.7	9.8	12.4	15.5	19.3	24.7
xvi)	40	10	3.0	3.8	4.9	6.1	7.6	9.7	12.2	15.2	19.0	24.4
xvii)	40	25	3.0	3.7	4.8	6.0	7.5	9.5	11.9	14.9	18.7	23.9
xviii)	40	50	2.9	3.7	4.7	5.9	7.3	9.3	11.8	14.7	18.4	23.5
xix)	50	5	2.7	3.4	4.3	5.4	6.7	8.5	10.7	13.4	16.8	21.5
xx)	50	10	2.6	3.3	4.2	5.3	6.6	8.4	10.6	13.2	16.5	21.2
xxi)	50	15	2.6	3.3	4.2	5.2	6.6	8.3	10.5	13.1	16.4	21.0
xxii)	60	5	2.4	2.9	3.8	4.7	5.9	7.5	9.4	11.8	14.7	18.8

**Table 17 Allowable Working Pressure for Pipes made from PE 100,
and Overall Service (Design) Coefficient 1.6**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	3.9	4.9	6.3	7.8	9.8	12.4	15.6	19.6	24.4	31.3
ii)	10	10	3.9	4.8	6.2	7.7	9.6	12.2	15.4	19.3	24.1	30.8
iii)	10	25	3.8	4.7	6.0	7.6	9.4	12.0	15.1	18.9	23.6	30.2
iv)	10	50	3.7	4.6	6.0	7.4	9.3	11.8	14.9	18.6	23.2	29.8
v)	10	100	3.7	4.6	5.9	7.3	9.2	11.6	14.7	18.3	22.9	29.3
vi)	20	5	3.3	4.1	5.3	6.6	8.2	10.5	13.2	16.5	20.6	26.3
vii)	20	10	3.2	4.1	5.2	6.5	8.1	10.3	13.0	16.2	20.3	26.0
viii)	20	25	3.2	4.0	5.1	6.4	8.0	10.1	12.7	15.9	19.9	25.4
ix)	20	50	3.1	3.9	5.0	6.3	7.8	9.9	12.5	15.7	19.6	25.1
x)	20	100	3.1	3.9	4.9	6.2	7.7	9.8	12.3	15.4	19.3	24.7
xi)	27	5	2.8	3.5	4.5	5.6	7.0	8.9	11.2	14.0	17.5	22.4
xii)	27	10	2.8	3.5	4.4	5.5	6.9	8.8	11.1	13.8	17.3	22.1
xiii)	27	25	2.7	3.4	4.3	5.4	6.8	8.6	10.8	13.5	16.9	21.7
xiv)	27	50	2.7	3.3	4.3	5.3	6.7	8.5	10.7	13.3	16.7	21.3
xv)	40	5	2.4	3.0	3.9	4.8	6.0	7.7	9.7	12.1	15.1	19.3
xvi)	40	10	2.4	3.0	3.8	4.8	5.9	7.5	9.5	11.9	14.9	19.0
xvii)	40	25	2.3	2.9	3.7	4.7	5.8	7.4	9.3	11.7	14.6	18.7
xviii)	40	50	2.3	2.9	3.7	4.6	5.7	7.3	9.2	11.5	14.4	18.4
xix)	50	5	2.1	2.6	3.4	4.2	5.2	6.7	8.4	10.5	13.1	16.8
xx)	50	10	2.1	2.6	3.3	4.1	5.2	6.6	8.3	10.3	12.9	16.5
xxi)	50	15	2.0	2.6	3.3	4.1	5.1	6.5	8.2	10.2	12.8	16.4
xxii)	60	5	1.8	2.3	2.9	3.7	4.6	5.8	7.3	9.2	11.5	14.7

**Table 18 Allowable Working Pressure for Pipes made from PE 100,
and Overall Service (Design) Coefficient 2**

(Clause B-1)

Sl No.	Temperature	Years of Service	SDR 41	SDR 33	SDR 26	SDR 21	SDR 17	SDR 13.6	SDR 11	SDR 9	SDR 7.4	SDR 6
	°C		Maximum Allowable Operating Pressure MPa									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	10	5	3.1	3.9	5.0	6.3	7.8	9.9	12.5	15.6	19.6	25.0
ii)	10	10	3.1	3.9	4.9	6.2	7.7	9.8	12.3	15.4	19.3	24.7
iii)	10	25	3.0	3.8	4.8	6.0	7.6	9.6	12.1	15.1	18.9	24.2
iv)	10	50	3.0	3.7	4.8	6.0	7.4	9.4	11.9	14.9	18.6	23.8
v)	10	100	2.9	3.7	4.7	5.9	7.3	9.3	11.7	14.7	18.3	23.5
vi)	20	5	2.6	3.3	4.2	5.3	6.6	8.4	10.5	13.2	16.5	21.1
vii)	20	10	2.6	3.2	4.2	5.2	6.5	8.2	10.4	13.0	16.2	20.8
viii)	20	25	2.5	3.2	4.1	5.1	6.4	8.1	10.2	12.7	15.9	20.4
ix)	20	50	2.5	3.1	4.0	5.0	6.3	8.0	10.0	12.5	15.7	20.0
x)	20	100	2.5	3.1	3.9	4.9	6.2	7.8	9.9	12.3	15.4	19.7
xi)	27	5	2.2	2.8	3.6	4.5	5.6	7.1	9.0	11.2	14.0	18.0
xii)	27	10	2.2	2.8	3.5	4.4	5.5	7.0	8.8	11.1	13.8	17.7
xiii)	27	25	2.2	2.7	3.5	4.3	5.4	6.9	8.7	10.8	13.5	17.3
xiv)	27	50	2.1	2.7	3.4	4.3	5.3	6.8	8.5	10.7	13.3	17.1
xv)	40	5	1.9	2.4	3.1	3.9	4.8	6.1	7.7	9.7	12.1	15.5
xvi)	40	10	1.9	2.4	3.0	3.8	4.8	6.0	7.6	9.5	11.9	15.2
xvii)	40	25	1.9	2.3	3.0	3.7	4.7	5.9	7.5	9.3	11.7	14.9
xviii)	40	50	1.8	2.3	2.9	3.7	4.6	5.8	7.3	9.2	11.5	14.7
xix)	50	5	1.7	2.1	2.7	3.4	4.2	5.3	6.7	8.4	10.5	13.4
xx)	50	10	1.7	2.1	2.6	3.3	4.1	5.2	6.6	8.3	10.3	13.2
xxi)	50	15	1.6	2.0	2.6	3.3	4.1	5.2	6.6	8.2	10.2	13.1
xxii)	60	5	1.5	1.8	2.4	2.9	3.7	4.7	5.9	7.3	9.2	11.8

ANNEX C

(Foreword)

COMMITTEE COMPOSITION

Plastic Piping System Sectional Committee, CED 50

<i>Organization</i>	<i>Representative(s)</i>
Central Institute of Plastic Engineering and Technology, Chennai	DR S. K. NAYAK (Chairman)
Borouge India Pvt Ltd, Mumbai	SHRI PRASHANT D. NIKHADE
Brihan Mumbai Licensed Plumbers Association, Mumbai	SHRI KISHOR V. MERCHANT SHRI BIJAL M. SHAH (<i>Alternate</i>)
Central Institute of Plastic Engineering and Technology, Chennai	DR S. N. YADAV SHRI D. ANJANEYA SHARMA (<i>Alternate</i>)
Central Public Health Environmental Engineering Organization, New Delhi	ADVISER (PHE) ASSISTANT ADVISER (PHE) (<i>Alternate</i>)
Central Public Works Department, New Delhi	SHRI M. K. SHARMA SHRI AMAR SINGH (<i>Alternate</i>)
Chennai Metropolitan Water Supply & Sewerage Board, Chennai	ENGINEERING DIRECTOR SUPERINTENDING ENGINEER (P & D) (<i>Alternate</i>)
CSIR-Central Building Research Institute, Roorkee	DR B. SINGH SHRI RAJIV KUMAR (<i>Alternate</i>)
CSIR-National Environmental Engineering Research Institute, Nagpur	DR (SHRIMATI) ABHA SARGONKAR DR RITESH VIJAY (<i>Alternate</i>)
Delhi Development Authority, New Delhi	SUPERINTENDING ENGINEER (D) EXECUTIVE ENGINEER (R & D) (<i>Alternate</i>)
Delhi Jal Board, New Delhi	SHRI Y. K. SHARMA SHRI S. L. MEENA (<i>Alternate</i>)
Department of Chemical & Petrochemicals Govt of India, New Delhi	JOINT INDUSTRIAL ADVISOR
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GAIL India Limited, New Delhi	SHRI MANISH KHANDELWAL SHRI KULDEEP NEGI (<i>Alternate</i>)
Government e-Marketplace, New Delhi	REPRESENTATIVE
Haldia Petrochemicals Ltd, Kolkata	SHRI RAJ K. DATTA SHRI AMARTYA MAITY (<i>Alternate</i>)
Indian Oil Corporation Ltd, Panipat	SHRI DHANANJAY SAHOO SHRI RAJA PODDAR (<i>Alternate</i>)
Jain Irrigation System Limited, Jalgaon	SHRI S. NARAYANASWAMI SHRI P. H. CHAUDHARI (<i>Alternate</i>)
Kolkata Municipal Corporation, Kolkata	SHRI D. K. SANYAL SHRI A. K. BISWAS (<i>Alternate</i>)
Mahindra EPC Irrigation Ltd, Nashik	SHRI SANKAR KUMAR MAITI SHRI C. V. JOSHI (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
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NSF Safety and Certification India PvtLtd, Gurugram	SHRI B. B. SINGH SHRI NASRIN KASHEFI (<i>Alternate</i>)
Odisha PVC Pipes Manufacturing Association, Bhubaneswar	SHRI NIKUNJ CHHOTRAY
Panchayati Raj and Drinking Water Department, Govt of Odisha, Bhubaneswar	CHIEF ENGINEER
Plastindia Foundation, Mumbai	SHRI RAJIV J. RAVAL DR E. SUNDARESAN (<i>Alternate</i>)
Public Health Engineering Department, Jaipur	SUPERINTENDING ENGINEER EXECUTIVE ENGINEER (<i>Alternate</i>)
Reliance Industries Limited, Mumbai	SHRI S. V. RAJU SHRI SAURABH BAGHAL (<i>Alternate</i>)
RITES Limited, New Delhi	SHRI PANKAJ AGGARWAL SHRI MUKESH SINHA (<i>Alternate</i>)
Shaktiman Extrusions Pvt Ltd, Perumbavoor	SHRI N. SURESH SHRI T. S. MANOJ (<i>Alternate</i>)
Supreme Industries Limited, Jalgaon	SHRI G. K. SAXENA
Tamil Nadu Water Supply & Drainage Board, Chennai	ENGINEERING DIRECTOR JOINT CHIEF ENGINEER (COM) (<i>Alternate</i>)
In Personal Capacity (A-59, Sector 35, Noida 201 301)	SHRI KANWAR A. SINGH
In Personal Capacity (L-202 Metrozone, Anna Nagar West Chennai 600 040)	SHRI G. K. SRINIVASAN
BIS Directorate General	SHRI SANJAY PANT, SCIENTIST 'F' AND HEAD (CED) [REPRESENTING DIRECTOR GENERAL (<i>Ex-officio</i>)]

Member Secretary

SHRIMATI MADHURIMA MADHAV
SCIENTIST 'D' (CIVIL ENGINEERING), BIS

Polyolefins and GRP Piping System Subcommittee, CED 50 : 1

<i>Organization</i>	<i>Representative(s)</i>
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Alom Poly Extrusion Ltd, Kolkata	SHRI ARNAV JHUNJHUNWALA SHRI ANIK KUMAR CHOWDHURY (<i>Alternate</i>)
Assam Gas Company Limited, Dibrugarh	SHRI SURJAYA TAMULIK SHRI AHIJIT BARUAH (<i>Alternate</i>)
Bhimrajka Impex Limited, Mumbai	SHRI VINOD BHIMRAJKA
Central Ground Water Board, Faridabad	SHRI D. N. ARUN SHRI K. R. BISWAS (<i>Alternate</i>)
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CSIR-National Environmental Engineering Research Institute, Nagpur	DR (SHRIMATI) ABHA SARGAONKAR DR RITESH VIJAY (<i>Alternate</i>)
Chennai Water Supply & Sewerage Board, Chennai	ENGINEERING DIRECTOR CHIEF ENGINEER (O & M) (<i>Alternate</i>)
Delhi Jal Board, New Delhi	SHRI Y. K. SHARMA SHRI S. L. MEENA (<i>Alternate</i>)
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Engineers India Ltd, New Delhi	SHRI N. KAUL SHRI R. B. BHUTDA (<i>Alternate</i>)
EPP Composite Pipes, Rajkot	SHRI JAYRAJ SHAH SHRIMATI SEEMA VAIDYA (<i>Alternate</i>)
GAIL India Limited, New Delhi	DR DEBASISH ROY SHRI MANISH KHANDELWAL (<i>Alternate</i>)
Godavari Polymers Pvt Limited, Secunderabad	SHRI C. VENKATESHWAR RAO SHRI G. SRIDHAR RAO (<i>Alternate</i>)
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Indraprastha Gas Limited, New Delhi	REPRESENTATIVE
Industrial Toxicology Research Centre, Lucknow	DR V. P. SHARMA DR VIRENDRA MISRA (<i>Alternate</i>)
Jain Irrigation Systems Limited, Jalgaon	SHRI M. R. KHARUL SHRI M. D. CHAUDHARI (<i>Alternate</i>)
Kimplas Piping Systems Ltd, Nashik	SHRI KIRAN SARODE SHRI SANTOSH KUMAR (<i>Alternate</i>)
KITEC Industries India Limited, Mumbai	SHRI DALIP V. KOLHE SHRI MANORANJAN G. CHOUDHARY (<i>Alternate</i>)
Mahanagar Gas Limited, Mumbai	SHRI K. VENUGOPAL SHRIMATI NEHA KHARYA (<i>Alternate</i>)
Mahanagar Telephone Nigam Limited, New Delhi	CHIEF ENGINEER (BW)
Maruthi Tubes Pvt Ltd, Secunderabad	SHRI MANCHAALA RAGHAVENDRA SHRI M. NAGESH KUMAR (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
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Ori-Plast Limited, Kolkata	SHRI ASHISH AGARWAL SHRI SOMNATH MUKHERJEE (<i>Alternate</i>)
Public Health & Municipal Engineering Department, Hyderabad	SHRI K. SURESH KUMAR SHRI CH. MALLIKARJUNUDU (<i>Alternate</i>)
Reliance Industries Limited, Mumbai	SHRI S. V. RAJU SHRI SAURABH BAGHAL (<i>Alternate I</i>) SHRI TUSHAR DONGRE (<i>Alternate II</i>)
In Personal Capacity (<i>H-23/01, Panchjyot Society, Sector 29, Vashi, Navi Mumbai 400 703</i>)	SHRI V. K. SHARMA

Panel for Revision of IS 4984 and IS 14333, CED 50:P2

<i>Organization</i>	<i>Representative(s)</i>
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(Continued from second cover)

- f) Pipe stiffness properties for different MRS and SDR pipes have been added for guidance for ascertaining pipe external load bearing capability.
- g) Tests for oxidation induction time, volatile matter content and water content for resin have been included.
- h) Chemical resistance of polyethylene and its compatibility with various fluids and its performance in different general uses has been recommended based on IS 16268/ISO TR 10358.

In this revision of the standard, considerable assistance has been derived from the following international standards:

DIN 8074 : 1999-08 Polyethylene (PE) Pipes — PE 80, PE 100 — Dimensions

BS EN ISO 15494 : 2015 'Plastic Piping Systems for Industrial Applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PERT), crosslinked polyethylene (PE-X), polypropylene (PP) — Metric series of specifications for components and the system'

For guidance on laying and jointing of polyethylene pipes, including storage and handling, reference may be made to IS 7634 (Part 1 and 2).

The composition of the technical committee responsible for formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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